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ABSTRACT

The technique of path analysis was used to test the role of student task engagement as a mediating process variable linking teacher behavior and student achievement in mathematics and social studies classes. Study participants included 40 teacher interns and their respective second-, third-, and fifth-grade classes from a school district served by the University of South Florida (Tampa). Class size ranged from 20 to 30 students. Two measures of teacher behavior and a measure of student task engagement were obtained during lessons from 2-week instructional units designed specifically for the study. Achievement was defined as the class mean residualized gain score, residualizing student posttest scores on both content pretest performance and scores on the relevant subtests of the Comprehensive Tests of Basic Skills. Results suggest different causal paths from teacher behavior to achievement in the two contexts. In social studies classes, task engagement emerged as a mediating variable as hypothesized, while in mathematics classes, task engagement played no causal role in achievement. Results were interpreted as an example of the added information obtained from testing path models rather than examining only zero-order correlations. Four data tables and three figures are included. (Author/SLD)

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TEACHER BEHAVIOR, TASK ENGAGEMENT, AND STUDENT ACHIEVEMENT: A PATH ANALYTIC STUDY

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Teacher Behavior, Task Engagement, and Student Achievement: A Path Analytic Study

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ABSTRACT. The technique of path analysis was used to test the role of student task engagement as a mediating process variable linking teacher behavior and student achievement in math and social studies classes. Forty teacher-interns and their respective elementary level classes participated in the study. Two measures of teacher behavior and a measure of student task engagement were obtained during lessons from two-week instructional units designed specifically for the study. Achievement was defined as the class mean residualized gain score, residualizing student posttest scores on both content pretest performance and scores on relevant subtests of the Comprehensive Test of Basic Skills. Results suggest different causal paths from teacher behavior to achievement in the two contexts. In social studies classes, task engagement emerged as a mediating variable as hypothesized, while in mathematics classes it played no causal role in achievement. Results were interpreted as an example of the added information obtained from testing path models rather than examining only zero-order correlations.

Research that relates teacher behaviors and student achievement typically presents results in terms of zero-order correlation coefficients between some measure of teaching and some measure of student learning. The presentation of significant coef-

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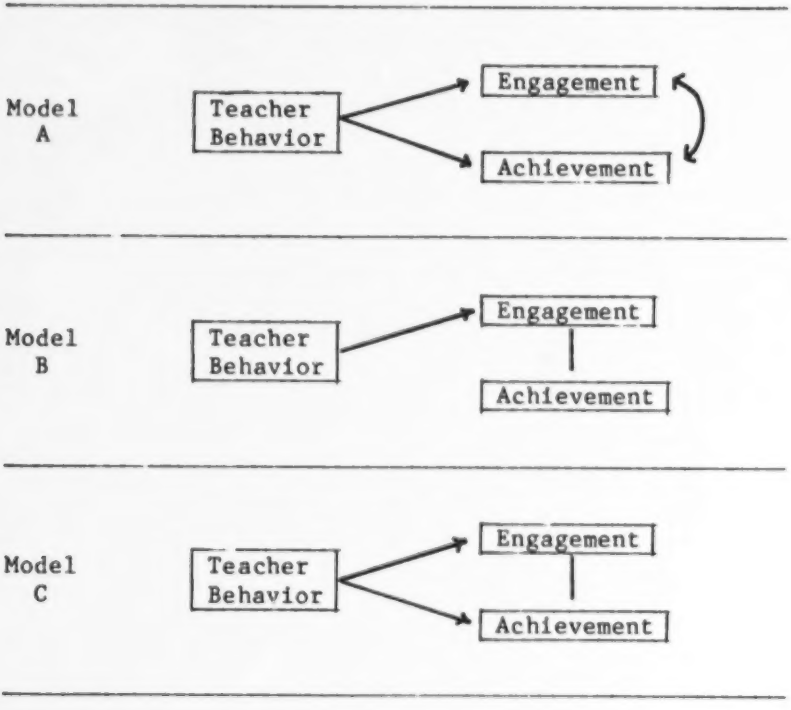
ficients in such circumstances leads to the conclusion that the teacher behaviors are directly associated with student learning. The role that other variables, such as mediating process variables, play in student learning is often ignored. In many instances, limiting examinations of relationships among variables to simple bivariate correlations does not provide the opportunity to explore the inter-relationships among variables in the complex teaching-learning environment. The technique of path analysis (Pedhazur, 1982; Li, 1975) provides an extension of the correlation method which yields more information about the processes by which significant zero-order coefficients result.

The purpose of this study is to determine the nature and strength of the relationship among certain teacher behaviors, class engagement in academic tasks (task engagement), and student achievement. The study demonstrates the type of information obtainable from path analysis that is lost if the analysis of these relationships is limited to simple zero-order correlations. A model relating teacher behavior, class engagement in academic tasks, and class achievement was tested in two subject areas in elementary classrooms. It was hypothesized that task engagement mediates the effect of teacher behavior on student achievement.

Figure 1 presents three path diagrams detailing possible relations among the three variables of interest. Model A proposes causal effects of teacher behavior on both engagement and achievement (straight single-headed arrow from the cause to the effect). In this model, engagement and achievement are correlated, but neither is hypothesized to causally influence the other (curved double-headed arrow). In contrast, Model B hypothesizes a causal effect of teacher behavior on task engagement and a subsequent causal effect of engagement on achievement, but no direct effect of teacher behavior on achievement. In this model, all of the effects of teacher behavior on achievement are mediated by task engagement. A more complex model is presented in Model C. Here, teacher behavior has both a direct effect on achievement and an indirect effect on achievement mediated through task engagement. The path model employed in this study is an adaptation of

Figure 1

Three Path Models Relating Teacher Behavior, Task Engagement, and Achievement



Model C. Two measures of teacher behavior, correlated with each other but not causally related, are hypothesized to causally affect student achievement through both a direct path and an indirect path that is mediated by task engagement. The advantage of path analysis is that zero-order correlations may be decomposed into direct and indirect effects. This decomposition aids understanding the relationships among sets of variables.

The study was conducted using data originally collected for an internship research project at the University of South Florida (Teacher Education Internship Project, 1984). Interns in elementary education taught a two-week unit in either mathematics or social studies to their respective classes. Measures of teacher performance and task engagement were obtained by trained observers. Students in each classroom were given a pretest and a posttest on the content covered in the two-week lessons, yielding a measure of student achievement.

Subjects

Participants were 40 teacher-interns and their respective second-, third-, and fifth-grade classes in a school district served by the University. The teacher-interns were in the final semester of their senior year and were enrolled in the elementary education program in the College of Education. Sixteen interns were assigned to teach a two-week mathematics unit to their classes. The remaining 24 interns were assigned to teach a two-week social studies unit to their classes. Class size ranged from 20 to 30 students.

Lessons

The content covered in the social studies units for the second and third grades related to the concept of symbols and their use; and content for the fifth-grade unit related to the concept of greatness and the lives of two great men in American history. The content covered in the mathematics units related to fractions. The guiding criteria for content choice were that the

content: (1) had not yet been taught to students, (2) would blend with the existing curriculum in the schools, and (3) would be of interest to and at an appropriate level of difficulty for the students. All materials and tests were developed by College of Education content specialists in conjunction with subject specialists from the College of Arts and Science and the College of Social Science.

Instrumentation

Florida Performance Measure System (FPMS) Summative Observation Instrument. The FPMS Summative Observation Instrument (FPMS, 1983) was the instrument used by trained observers to obtain measures of interns' teaching performance. It is a categorical observation system composed of 37 low-inference behavioral indicators. The instrument is divided into two scales: one consisting of 20 indicators (Scale A) and the other consisting of 17 indicators (Scale B). Behaviors on Scale A may be regarded as teacher behaviors which facilitate student learning, while behaviors on Scale B may be regarded as inhibitors to student learning. For the purposes of this study, observational data were scored to yield two teacher performance scores -- one for Scale A behaviors and the other for Scale B behaviors. Scores on Scale B were reversed so that teachers exhibiting fewer of the inhibiting behaviors received a higher score on the scale. Reliability studies on the FPMS instrument estimate an interobserver agreement coefficient of 0.85 for Scale A and 0.47 for Scale B (Micceri, 1984).

Task Engagement. Measures of task engagement were obtained by the observers on four different occasions during each observation period. The first measure was taken five minutes after the start of the lesson, the remaining three at 8-minute intervals thereafter. The task engagement measures were obtained by counting the number of students in the class who were not engaged in the required lesson activities at the given point in time and then computing the proportion of students in the class who were engaged appropriately. The mean proportion engaged over the four measures taken during each lesson was used as the estimate of task engage-

ment for that lesson.

Instructional Units and Unit Tests. Six instructional units, three in mathematics and three in social studies (one for each grade level), were developed for the purposes of this study. Each unit contained ten 30-minute lessons to be taught over a two-week period. The content and skills covered in each unit were judged by subject specialists to be appropriate and relevant for the given grade level.

Two alternative forms of a unit test were developed for each unit. One form was administered as a pretest and the other as a posttest to obtain measures of student achievement. Internal consistency estimates of reliability for the social studies and mathematics tests ranged from 0.70 to 0.75.

Comprehensive Test of Basic Skills (CTBS). Students' scores on the math and reading subtests of the CTBS examination were obtained from district files. These scores were used in conjunction with math and social studies unit pretest scores to obtain relevant residulized gain scores as achievement measures for the students.

Procedure

Prior to the start of instruction on the unit, students in each class were given a unit pretest. Interns then taught the two-week math or social studies unit to their respective classes. To control for the possible confounding effects of extraneous teaching influence on achievement, supervising teachers and university professors were requested not to give specific assistance to interns in the teaching of these lessons. During this period, each intern was observed on two different occasions (once each week) by two different trained observers while teaching a lesson in the unit. In addition to recording teacher behavior, observers also obtained a measure of task engagement on four different occasions during each observed lesson.

On completion of the unit, students were given a unit posttest. Student achievement was computed as regressed gain scores. Posttest scores were regressed on pretest scores and CTBS scores in the related sub-

ject. The class mean residual from this regression served as the measure of class achievement. Class means were used as the unit of analysis for the study.

Results

Means and standard deviations of class scores on content tests, teacher performance, and task engagement are presented in Table 1 for the mathematics and social studies lessons. The mean mathematics pretest score was 9.7 while the mean posttest score was 15.0. On both examinations, the standard deviation among class means was 2.9. The mean task engagement score (i.e., the average proportion of class engaged in relevant academic tasks) was 0.86 with a standard deviation among classes of 0.06. For the social studies tests, variability among classes increased from pretest to posttest (from a standard deviation of 1.8 to 2.5), while the mean score increased from 11.3 to 16.4. Engagement in social studies lessons was similar to that in mathematics, having a mean of 0.87 and a standard deviation of 0.07.

Table 2 presents the correlation matrices relating teacher behavior, task engagement, and achievement for mathematics and social studies lessons. Examination of these matrices reveals a higher degree of relationship among the variables in the mathematics lessons than in the social studies lessons. For mathematics lessons, the highest correlations are between the Scale B teacher behaviors and both task engagement ($r = 0.77$, $p < .05$) and student achievement ($r = 0.64$, $p < .05$). In the social studies lessons, the correlation between Scale B behaviors and task engagement remains the highest correlation in the matrix ($r = 0.51$, $p < .05$) while that between Scale B behaviors and achievement drops to essentially zero ($r = -0.03$). In both matrices, a moderate, positive relationship is observed between task engagement and achievement ($r = 0.46$ and 0.35, $p < .10$ for the mathematics and social studies classes, respectively).

Separate path analyses were performed for each subject area. The data were combined across grade levels within subject areas because the initial analyses of these data suggested that achievement patterns were

Table 1

Means and Standard Deviations of Student Test Scores and Teacher Performance Measures for Mathematics and Social Studies

Measures	Mathematics $\bar{X}$	Mathematics SD	Social Studies $\bar{X}$	Social Studies SD
Pretest (class means)	9.7	2.9	11.3	1.8
Posttest (class means)	15.0	2.9	16.4	2.5
FPMS Scale A	49.0	8.7	48.4	7.7
FPMS Scale B	50.2	10.3	50.6	6.7
Task Engagement	.86	.06	.87	.07

Table 2

Zero-Order Correlations Between Teacher Performance Scores, Task Engagement, and Achievement for Mathematics and Social Studies

Classes	Engagement	Scale A	Scale B
Math (n=16)			
Achievement	.46*	.32	.64**
Engagement		.38	.77**
Scale A			.56**
Social Studies (n=24)			
Achievement	.35*	.22	-.03
Engagement		.17	.51**
Scale A			.22

*$p < .10$
**$p < .05$

not different among the second-, third-, and fifth-grade classes (Teacher Education Internship Project, 1984).

Mathematics Lessons

Figure 2 shows the path model for the mathematics classes. The numbers in parentheses are zero-order product-moment correlations, and the other numbers are path coefficients (standardized partial regression coefficients). The decomposition of the zero-order correlations among variables in the model is presented in Table 3. A significant correlation coefficient is observed between Scale B teacher performance scores and student achievement. Decomposition of this correlation shows a significant direct effect of the teacher performance measure on achievement (path coefficient = 0.74, $p < 0.05$), one that is even greater than the zero-order correlation ($r = 0.64$). This substantial direct effect indicates that less frequent use by the teacher of these ineffective behaviors (inhibitors of learning) resulted in higher levels of student achievement in the mathematics classes. The moderate zero-order correlation of 0.32 between Scale A teacher performance scores and student achievement results from: (1) a direct path coefficient of -0.06, (2) an indirect path coefficient of 0.01 and (3) a non-causal effect of 0.37. Both the direct and indirect paths from this measure of teacher behavior are essentially zero. Thus the observed correlation between Scale A teacher behaviors and student achievement is attributable almost entirely to non-causal effects (i.e. effects for which the direction of causation cannot be determined).

The significant zero-order correlation between task engagement and achievement ($r = 0.46$ $p < .10$) is decomposed into an essentially zero direct effect (path coefficient = -0.09) and a substantial non-causal effect of 0.55. The path diagram in Figure 2 clarifies the nature of this relationship between engagement and achievement. The obtained zero-order correlation results from both engagement and achievement sharing a common prior cause -- Scale B teacher behavior. Thus, the obtained correlation between

Figure 2

Path Model Relating Teacher Behavior, Task Engagement, and Achievement in Mathematics Classes

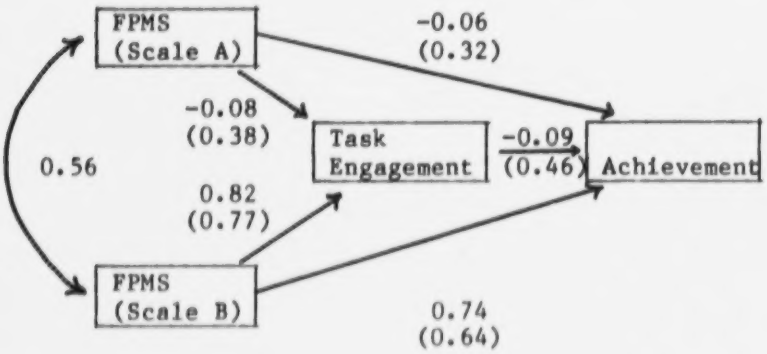


Table 3

A Decomposition of Zero-Order Correlations with Class Achievement for Mathematics Classes

Variables	Zero-Order Correlations	Effect		
		Direct	Indirect	Non-causal
Scale A	0.32	-0.06	0.01	0.37
Scale B	0.64**	0.74	-0.07	-0.03
Engagement	0.46*	-0.09	none	0.55

n = 16
*$p < .10$
**$p < .05$

engagement and achievement in mathematics classes is a spurious one.

Since the indirect effects associated with each of the two teacher performance measures was essentially zero, the hypothesized relationship of student task engagement as a mediator of the effects of teacher behavior on student achievement was not supported by the data from the mathematics classes.

Social Studies Lessons

The path diagram for the social studies classes is illustrated in Figure 3, and the decomposition of the zero-order correlations is presented in Table 4. Examination of the path diagram and the table suggests that in these classes, task engagement did mediate the effect of teacher behavior on student achievement. The path diagram and the table suggest that the effects of teacher behavior (as measured by Scale B) on achievement are accounted for by: (1) a direct path from teacher behavior to achievement (path coefficient = -0.32), and (2) an indirect path from teacher behavior through task engagement to achievement (path coefficient = 0.24).

An interesting and unanticipated result is the reversal of the direction of effects in comparing the direct and indirect paths. The appearance of a negative direct effect of teacher behavior on student achievement suggests that the occurence of fewer ineffective teacher behaviors is associated with less student learning. However, the positive indirect path from teacher behavior through task engagement to student achievement indicates that the less frequent the occurrence of these same inhibiting behaviors the greater was the task engagement, which in turn contributes to achievement (this is the mediating effect). Thus, the zero-order correlation is accounted for by a negative direct and a positive indirect effect of essentially the same magnitude resulting in a correlation which is nearly zero.

In contrast to the mediating effect obtained for Scale B behaviors, Scale A behaviors show only a direct effect on achievement (path coefficient = 0.21). As seen in the decomposition of correlations,

Figure 3

Path Model Relating Teacher Behavior, Task Engagement, and Achievement in Social Studies Classes

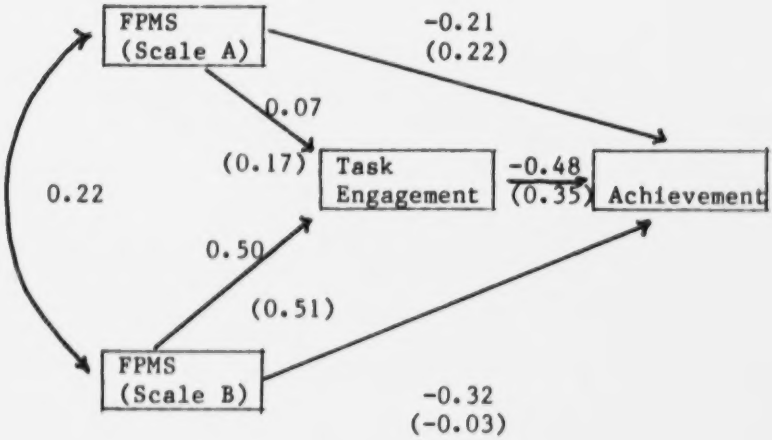


Table 4

A Decomposition of Zero-Order Correlations with Class Achievement for Social Studies Classes

Variables	Zero-Order Correlations	Effect		
		Direct	Indirect	Non-causal
Scale A	0.22	0.21	0.03	-0.02
Scale B	-0.03	-0.32	0.24	0.05
Engagement	0.35*	0.48	none	-0.13

n = 24
*$p < .10$

the indirect and non-causal effects for this teacher performance measure are essentially zero.

Examination of Figure 3 reveals that for the social studies classes, task engagement emerged as an important facilitator of student learning (path coefficient = 0.48). Its role as a mediating variable was associated with only the Scale B teacher behaviors (inhibitors of learning).

Discussion

In this study, positive relationships indicated by zero-order correlation coefficients were observed between the measures of teacher behavior, student task engagement, and student achievement in both the mathematics and social studies classes. However, investigation of the nature and strength of the relationships among these variables using path analysis revealed that the pattern of the relationships and the nature of the causal paths differed somewhat across the two content areas tested.

Partial support was provided for the hypothesized role of task engagement serving as a mediating process variable between teacher behavior and student achievement in the social studies lessons. In contrast, this hypothesis was not supported in the mathematics lessons. The relationship between teacher behavior and student achievement was explainable by the direct effect of teacher behavior (Scale B behaviors) on achievement. Task engagement served essentially no role in the causal path to achievement. The observed zero-order correlation between task engagement and achievement, though fairly substantial, was a spurious one and was explainable through the effect of teacher behavior on both achievement and engagement. This outcome is one which would have been missed completely in a cursory examination of the matrix of zero-order correlations among the variables of interest.

Our failure to document the hypothesized linkages between teacher behavior, task engagement, and student achievement in both settings does not disconfirm the hypothesis that task engagement serves as a mediating variable in the teaching-learning context. The non-observance of significant linkages as hypothesized may

be due to a number of uncontrollable factors in a field study such as this. On the other hand, it may be that differences in the very nature of the context and related activities across subject areas account, in part, for differences in the patterns of relationships observed.

The differences in relationships among variables in the two content areas tested in this study serve as a reminder that caution should be exercised in generalizing such relationships across contexts. The technology for testing causal paths among variables in the teaching-learning context is available and is a natural and simple extension of multiple correlation. The alternative, reliance on zero-order c orrelations, leaves room for misinterpretation of relationships.

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